Modelling the impact of new parkrun events: efficiency vs equity

Center for Chronic Disease Research and Policy University of Chicago

Dr Robert Smith | November 2024

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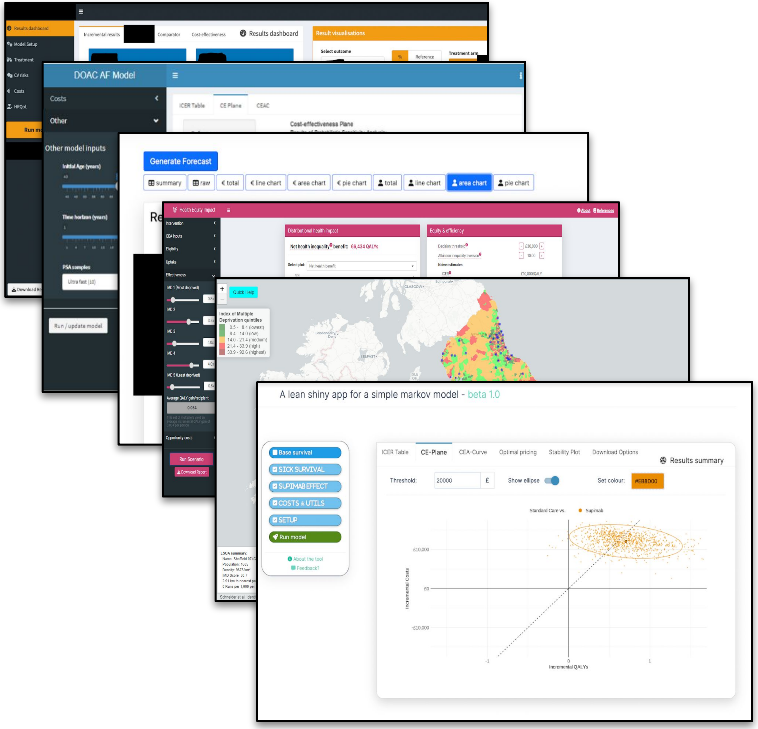
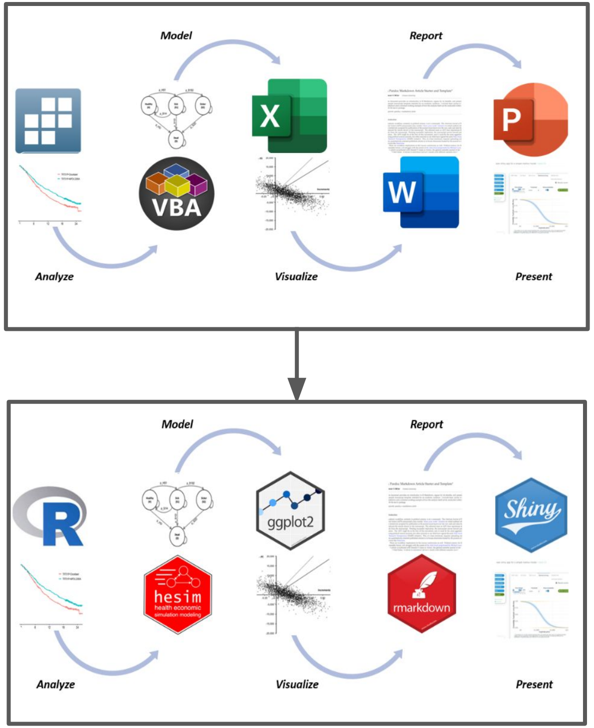
Who am I?

Robert Smith, PhD

1) Dark Peak Analytics
2) University of Sheffield

Shifting Health Economics to Script Based Models





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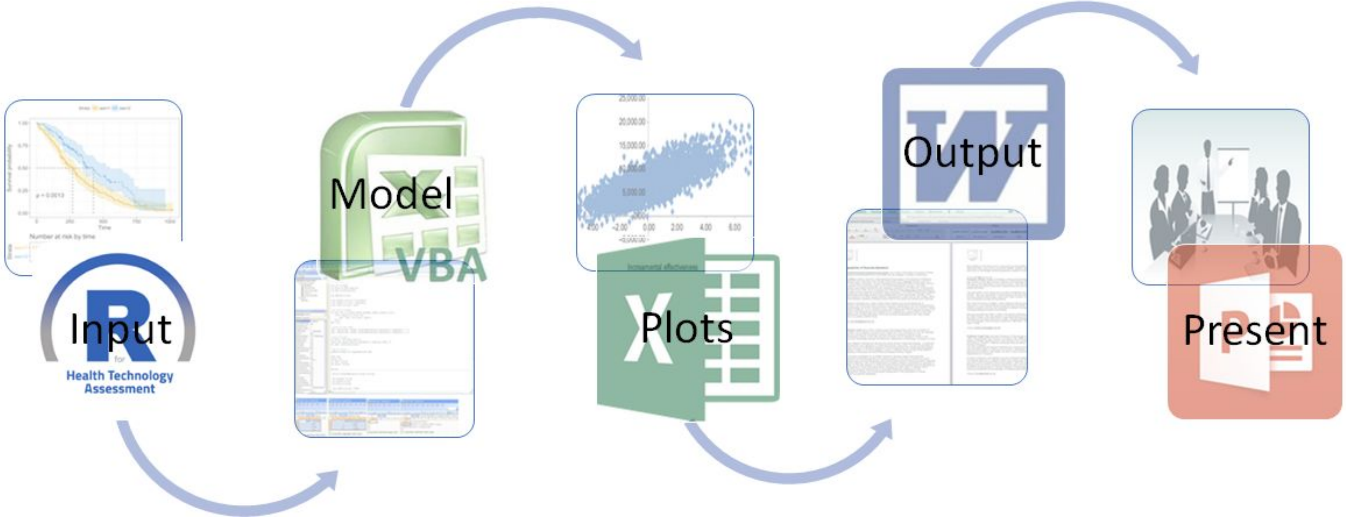
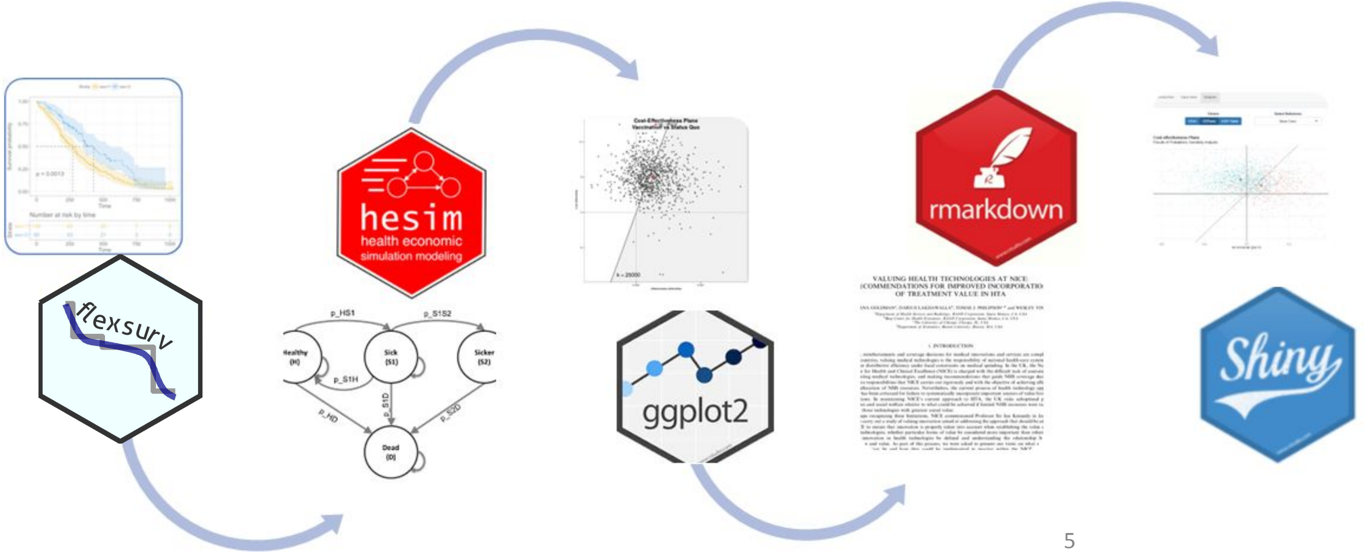
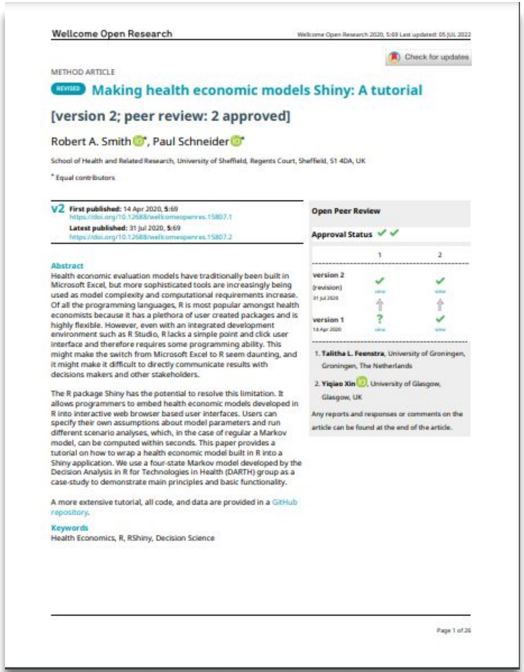


Future process



User-interfaces



Wellcome Open Research

Wellcome Open Research 2020, 5:69 Last updated: 05 JUL 2022

Check for updates

METHOD ARTICLE

REVISED **Making health economic models Shiny: A tutorial [version 2; peer review: 2 approved]**

Robert A. Smith*, Paul Schneider*

School of Health and Related Research, University of Sheffield, Regents Court, Sheffield, S1 4DA, UK

* Equal contributors

V2 **First published:** 14 Apr 2020, 5:69
https://doi.org/10.12688/wellcomeopenres.15807.1
Latest published: 31 Jul 2020, 5:69
https://doi.org/10.12688/wellcomeopenres.15807.2

Abstract

Health economic evaluation models have traditionally been built in Microsoft Excel, but more sophisticated tools are increasingly being used as model complexity and computational requirements increase. Of all the programming languages, R is most popular amongst health economists because it has a plethora of user created packages and is highly flexible. However, even with an integrated development environment such as R Studio, R lacks a simple point and click user interface and therefore requires some programming ability. This might make the switch from Microsoft Excel to R seem daunting, and it might make it difficult to directly communicate results with decisions makers and other stakeholders.

The R package Shiny has the potential to resolve this limitation. It allows programmers to embed health economic models developed in R into interactive web browser based user interfaces. Users can specify their own assumptions about model parameters and run different scenario analyses, which, in the case of regular a Markov model, can be computed within seconds. This paper provides a tutorial on how to wrap a health economic model built in R into a Shiny application. We use a four-state Markov model developed by the Decision Analysis in R for Technologies in Health (DARTH) group as a case-study to demonstrate main principles and basic functionality.

A more extensive tutorial, all code, and data are provided in a GitHub repository.

Keywords

Health Economics, R, RShiny, Decision Science

Open Peer Review

Approval Status ✓ ✓

	1	2
version 2 (revision) 31 Jul 2020	✓ view	✓ view
version 1 14 Apr 2020	? view	✓ view

1. **Talitha L. Feenstra**, University of Groningen, Groningen, The Netherlands
2. **Yiqiao Xin**, University of Glasgow, Glasgow, UK

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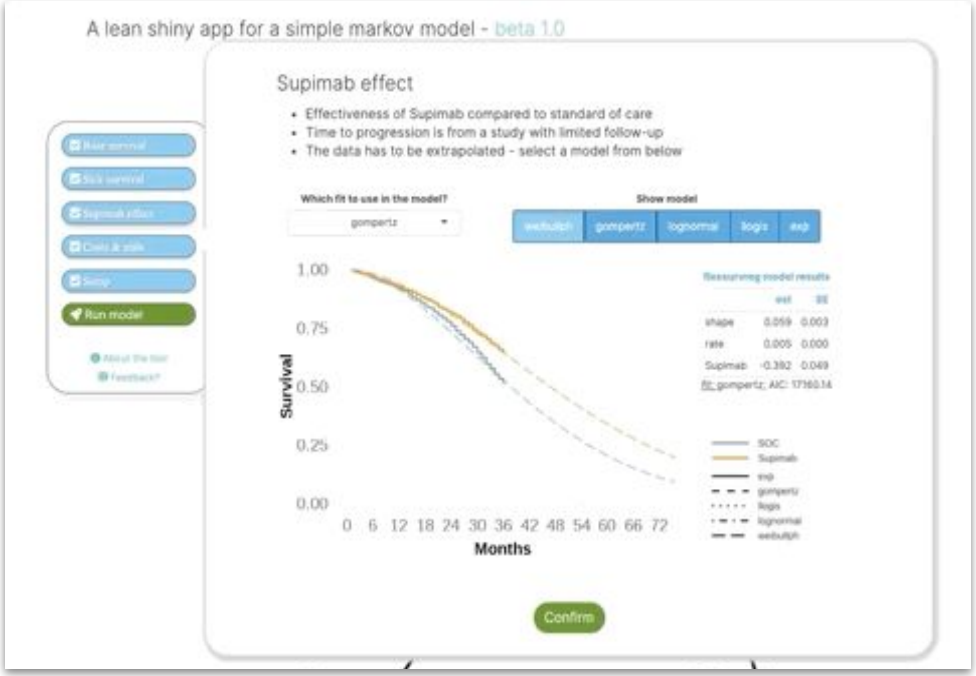
Page 1 of 26

Smith RA and Schneider PP. Making health economic models Shiny: A tutorial. Wellcome Open Res 2020, 5:69 (https://doi.org/10.12688/wellcomeopenres.15807.2)



https://darkpeakanalytics.shinyapps.io/sadm-mk2/

OK - stop talking about yourself!

Research collaboration

parkrun

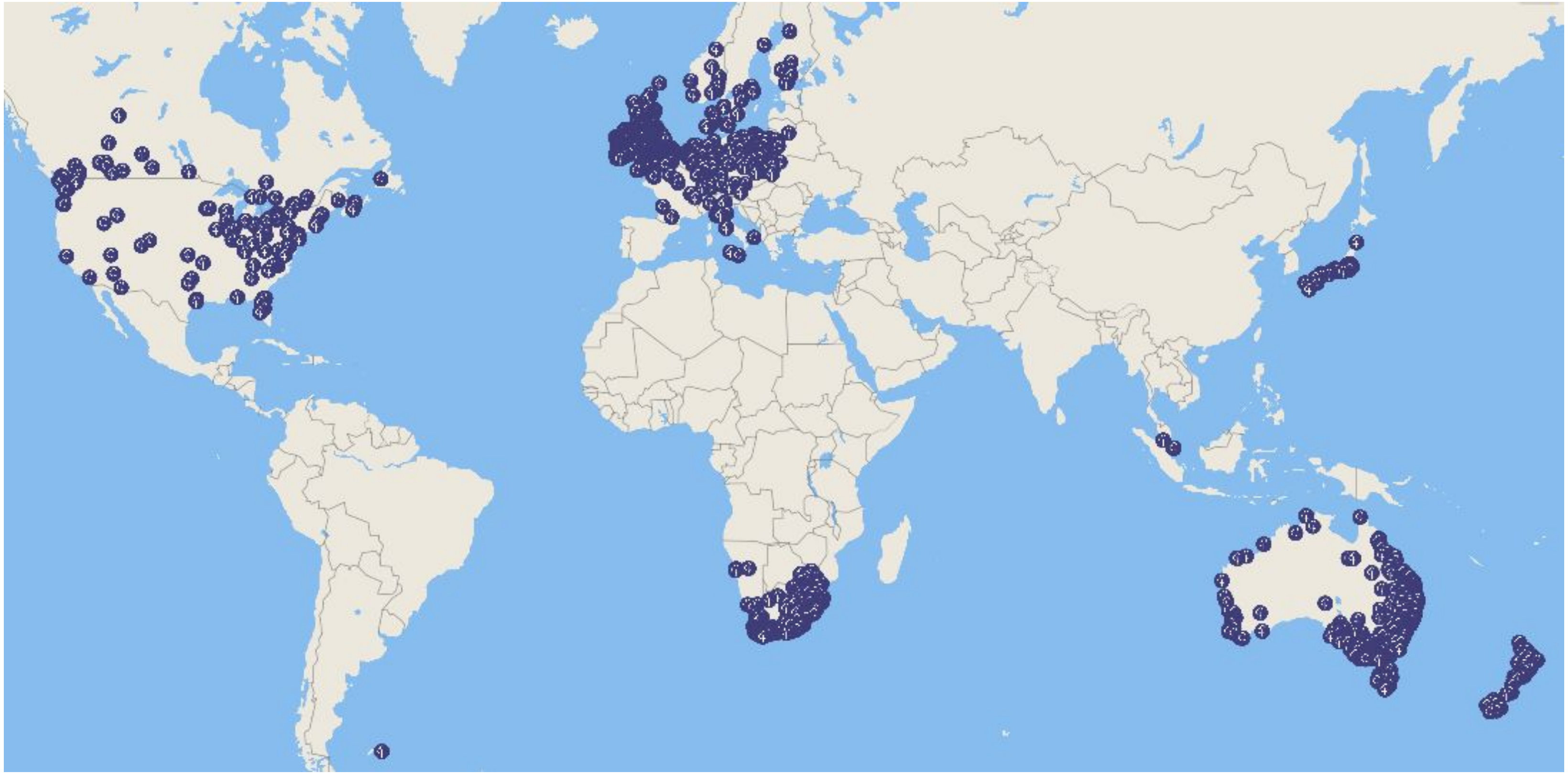
The University Of Sheffield.

Dr. Paul Schneider

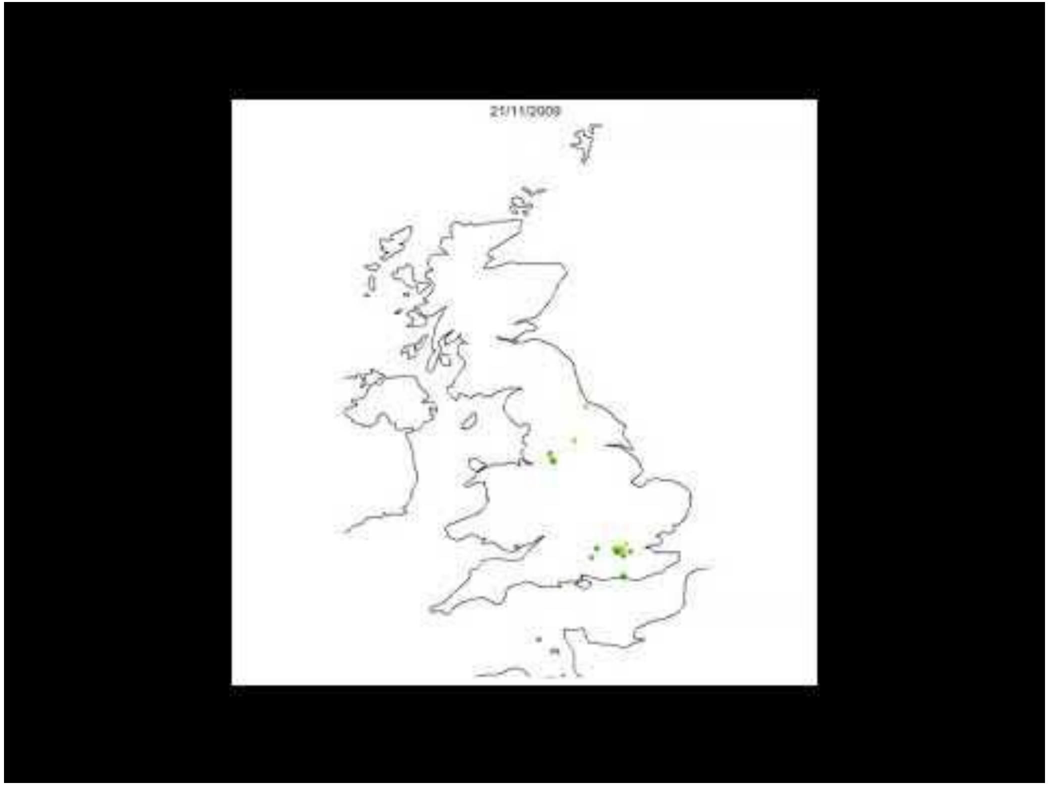
Dr. Robert Smith

This work was supported by funding from Wellcome [108903/B/15/Z and 108903] and the University of Sheffield. The funders had no role in study design; in the collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

Background



Background



https://www.youtube.com/watch?v=ktx4lujARdc&feature=share

Background

PARTNERSHIP WITH PARKRUN WORTH £3M

Collaboration aims to create 200 new events and boost participants from under-represented groups

12 December 2018 News Funding

Parkrun research publications


Wellcome Open Research

RESEARCH ARTICLE

Does ethnic density influence community participation in mass participation physical activity events? The case of parkrun in England [version 2; peer review: 3 approved]

Robert A. Smith, Paul P. Schneider, Alice Bullas, Steve Haake, Helen Quirk, Rami Cosulich, Elizabeth Goyder

2020


Public Health

Original Research

Multiple deprivation and geographic distance to community physical activity events — achieving equitable access to parkrun in England

P.P. Schneider, R.A. Smith, A.M. Bullas, H. Quirk, T. Bayley, S.J. Haake, A. Brennan, E. Goyder

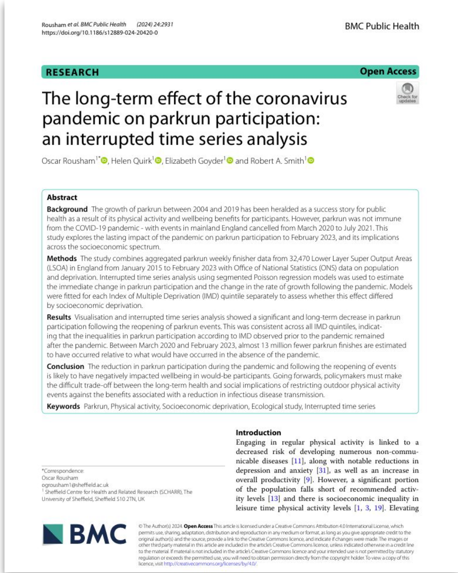
2020


Health and Place

Socioeconomic inequalities in distance to and participation in a community-based running and walking activity: A longitudinal ecological study of parkrun 2010 to 2019

Robert A. Smith, Paul P. Schneider, Rami Cosulich, Helen Quirk, Alice M. Bullas, Steve J. Haake, Elizabeth Goyder

2021


BMC Public Health

RESEARCH Open Access

The long-term effect of the coronavirus pandemic on parkrun participation: an interrupted time series analysis

Oscar Rousham, Helen Quirk, Elizabeth Goyder and Robert A. Smith

2024

Ethnicity, Deprivation & Access

Wellcome Open Research

Wellcome Open Research 2020, 5:9 Last updated: 05 JUL 2022

Check for updates

RESEARCH ARTICLE

REVISED **Does ethnic density influence community participation in mass participation physical activity events? The case of parkrun in England** [version 2; peer review: 3 approved]

Robert A. Smith[1], Paul P. Schneider[1], Alice Bullas[2], Steve Haake[2], Helen Quirk[2], Rami Cosulich[1], Elizabeth Goyder[1]

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v2 **First published:** 16 Jan 2020, **5**:9
https://doi.org/10.12688/wellcomeopenres.15657.1
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https://doi.org/10.12688/wellcomeopenres.15657.2

Abstract

Background: parkrun has been successful in encouraging people in England to participate in their weekly 5km running and walking events. However, there is substantial heterogeneity in parkrun participation across different communities in England: after controlling for travel distances, deprived communities have significantly lower participation rates.

Methods: This paper expands on previous findings by investigating disparities in parkrun participation by ethnic density. We combined geo-spatial data available through the Office for National Statistics with participation data provided by parkrun, and fitted multivariable Poisson regression models to study the effect of ethnic density on participation rates at the Lower layer Super Output Level.

Results: We find that areas with higher ethnic density have lower participation rates. This effect is independent of deprivation.

Conclusions: An opportunity exists for parkrun to engage with these communities and reduce potential barriers to participation.

Keywords
parkrun, Physical Activity, Ethnic Density, Deprivation

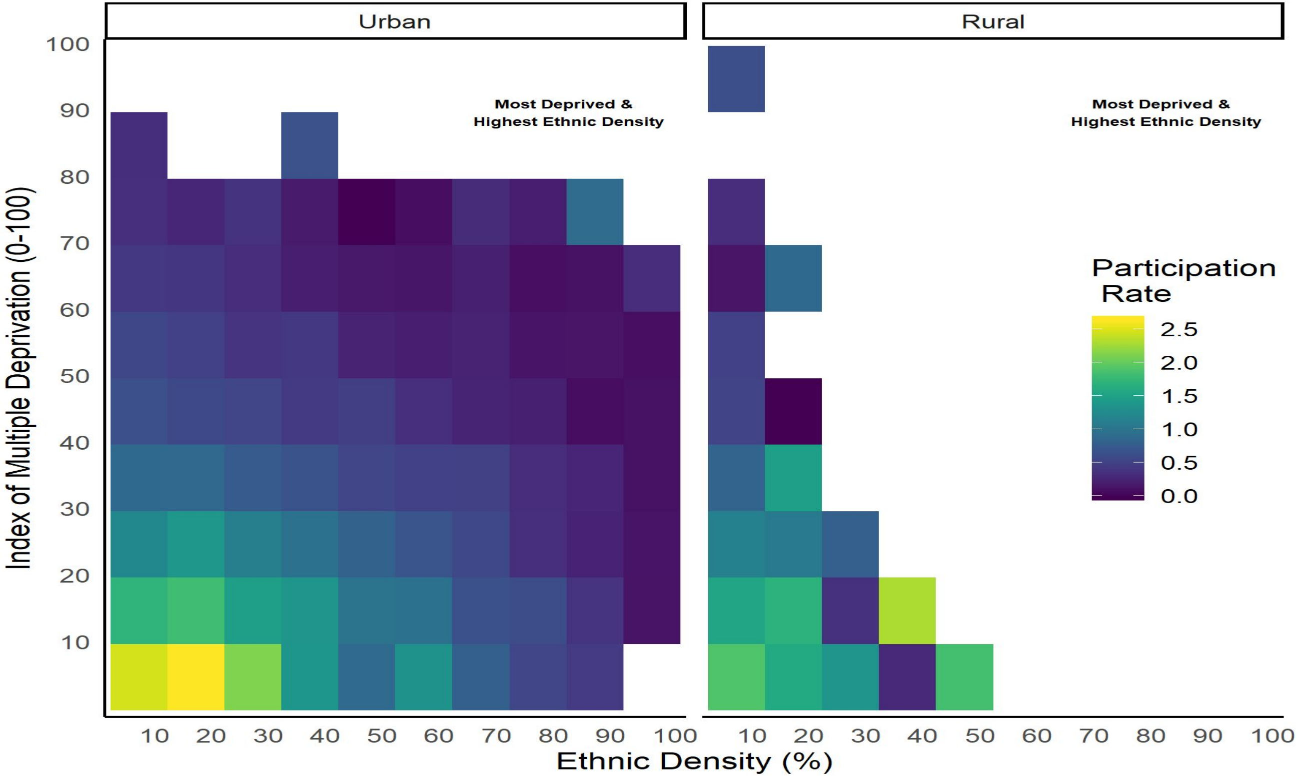
Open Peer Review

Approval Status ✓✓✓

	1	2	3
version 2 (revision) 18 Jun 2020	✓ view	✓ view	✓ view
version 1 16 Jan 2020	✓ view	✓ view	? view

1. **Anne Grunseit**, The Australian Prevention Partnership Centre, NSW, Australia
University of Sydney, Sydney, Australia
2. **Gozde Ozakinci**, University of St Andrews, St Andrews, UK
3. **Stephen Senn**, Consultant Statistician, Edinburgh, UK

Any reports and responses or comments on the article can be found at the end of the article.



Sources: Office for National Statistics and parkrunUK

Longitudinal study - participation & access

Health & Place 71 (2021) 102626

Contents lists available at ScienceDirect

Health and Place

journal homepage: www.elsevier.com/locate/healthplace

Socioeconomic inequalities in distance to and participation in a community-based running and walking activity: A longitudinal ecological study of parkrun 2010 to 2019☆,☆☆

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ARTICLE INFO

Keywords:
Parkrun
Physical activity
Socioeconomic deprivation
Ecological study
Relative index of inequality

ABSTRACT

Objectives: To conduct a longitudinal ecological analysis of the distance to and participation in free weekly outdoor physical activity events (parkrun) in England from 2010 to 2019, and related socioeconomic and ethnic inequalities, to inform policies to support participation in physically active community events.

Methods: We calculate distance to the nearest *parkrun* event for each English Lower Layer Super Output Area (LSOA) each month from January 2010 to December 2019. We then report the trends in distance to and participation in *parkrun* by Index of Multiple Deprivation quintile. We also report trends in the Relative Index of Inequality (RII) by deprivation for participation and distance to nearest event. We go on to investigate trends in LSOA level determinants (e.g. deprivation and ethnic density) of *parkrun* participation between 2010 and 2019, using multivariable Poisson regression models.

Results: Mean distance to the nearest *parkrun* event decreased from 34.1 km in 2010, to 4.6 km in 2019. Throughout the period, *parkrun* events tended to be situated closer to deprived areas compared to less deprived areas. Participation rates increased superlinearly (greater than linear increase) from 2010 to 2013 before slowing to linear growth. Participation over the period exhibits a clear socioeconomic gradient, with people from deprived areas having consistently lower participation rates over the period. *parkrun* participation rates became more equal between 2010 and 2013 (RII improved from 189 to 39), before stabilising at an RII between 32.9 and 39.6 from 2014 to 2019. The results of the Poisson regression model validate this finding; the coefficients on IMD score initially increased from −0.050 in 2010 to −0.038 in 2013, and then remained relatively stable to 2019 (−0.035).

Conclusions: Over the past 10 years, geodesic distance to the nearest *parkrun* decreased from a mean of 34 km to 5 km. In 2010, there was equality between the least and most deprived areas but by 2017 the distance of the most deprived areas was 29% that of the least deprived. Participation was shown to have increased over the past 10 years which can be split into two distinct phases: from 2010 to 2013 participation increased super-linearly and inequality in participation fell dramatically; from 2013 to 2019 participation increased linearly, and inequality in participation remained stable. Despite *parkrun*'s ambitions of creating inclusive events and engaging with deprived communities, the socioeconomic gradient in participation rates remained high and stable since 2013. Gaining a better understanding of the reasons why *parkrun* grew so quickly may be useful for other physical activity movements, while further analysis of the relatively lower participation rates in areas with higher

☆ R.S., P.S. & R.C. are joint funded by the Wellcome Trust Doctoral Training Centre in Public Health Economics and Decision Science [108903] and the University of Sheffield. H.Q. is funded by an NIHR School of Public Health Research (SPHR) post-doctoral launching fellowship. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. ☆☆ We would like to thank Mike Graney (Head of Analysis at parkrun) and Chrissie Wellington (Global Head of Health and Wellbeing at parkrun) for providing area level parkrun participation data.

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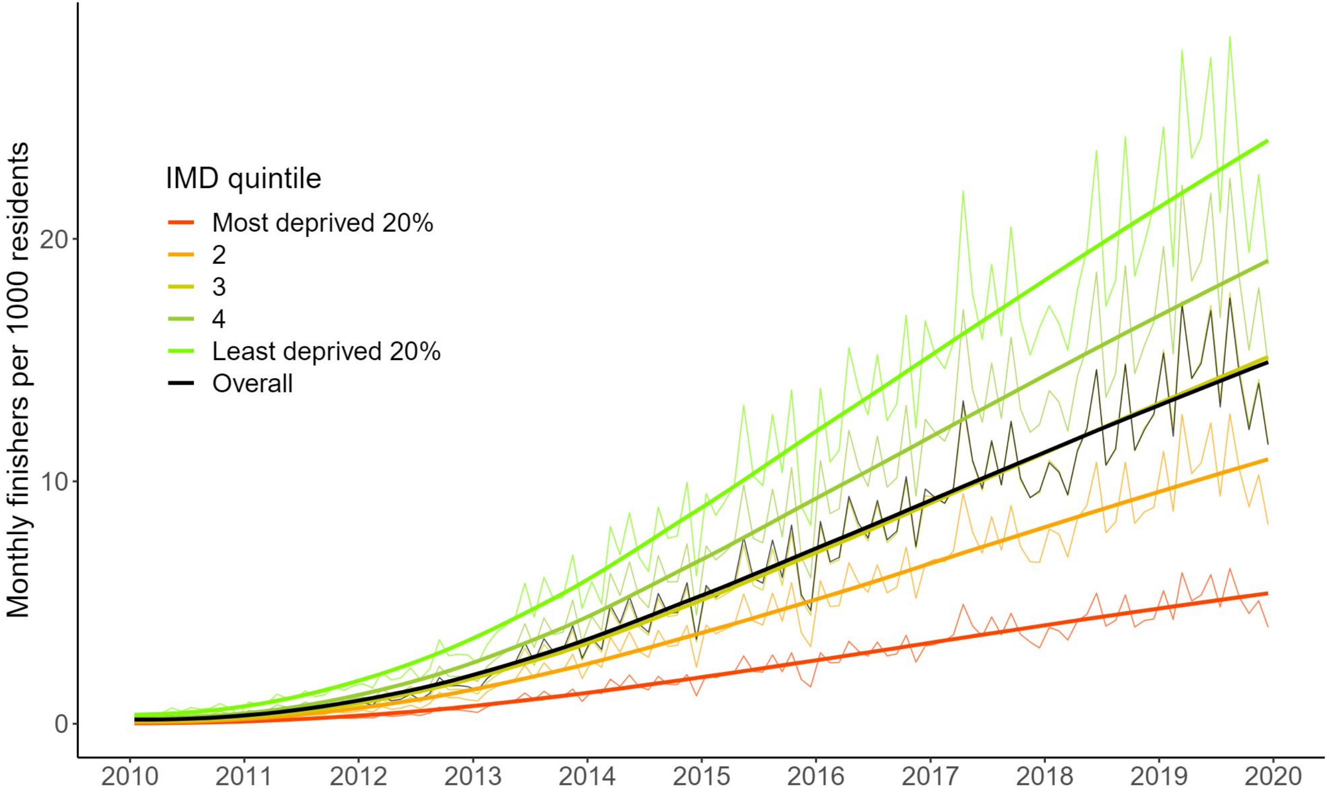
Available online 29 July 2021



Where should parkrun events be located?

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

Multiple deprivation and geographic distance to community physical activity events — achieving equitable access to parkrun in England

P.P. Schneider [a,*], R.A. Smith [a], A.M. Bullas [b], H. Quirk [a], T. Bayley [a], S.J. Haake [c], A. Brennan [a], E. Goyder [a]

[a] School of Health and Related Research, University of Sheffield, Sheffield, UK
[b] Centre for Sports Engineering Research, Sheffield Hallam University, Sheffield, UK
[c] Advanced Wellbeing Research Centre, Sheffield Hallam University, Sheffield, UK

ARTICLE INFO

Article history:
Received 31 May 2020
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Keywords:
Parkrun
Physical activity
Health inequalities
Health promotion
Geospatial analysis

ABSTRACT

Objectives: To evaluate geographic access to free weekly outdoor physical activity events ("parkrun") in England, with a particular focus on deprived communities, and to identify optimal locations for future events to further maximise access.
Study design: This study is a cross-sectional ecological analysis of the socio-economic disparities in geographic access to parkrun events in England in late 2018.
Methods: We combined geolocation data on all English Lower Layer Super Output Areas and parkrun events to calculate geodesic distances to the nearest event for more than 32,000 communities in England. We use this measure of geographic access to summarise the relationship between access and socio-economic deprivation, measured using the index of multiple deprivation. We then used geographic coordinates of public green spaces in England to conduct a simple location-allocation analysis to identify 200 locations for future event locations that would maximise access.
Results: In England, 69% of the population live within 5 km of one of the 465 parkrun events. There is a small negative correlation between distance and deprivation, indicating that access is slightly better in more socio-economically deprived areas. Setting up an additional 200 events in optimal locations would improve access: the average distance to the nearest parkrun event would improve by 1.22 km, from 4.65 km to 3.43 km, and approximately 82% of the English population would live within 5 km of a parkrun event.
Conclusion: Over two-thirds of the English population live within 5 km of a parkrun event, and contrary to our expectation, we find that geographic access is slightly better for those living in more deprived communities. Creating additional events may improve geographic access, but effective strategies will still be needed to increase engagement in new and existing events by those living in socio-economically deprived areas.

Introduction

Insufficient physical activity is one of the leading causes of disease and disability worldwide.[1] In the UK, around one in six deaths is attributable to low levels of physical activity.[2] It is also a major contributor to health inequalities, as people from low socio-economic backgrounds are both disproportionately likely to be inactive[3,4] and be affected by physical inactivity-related diseases.[5] Increasing the physical activity levels of the population is therefore high on the public health agenda: it not only has the potential to improve quality of life, reduce mortality rates and alleviate the strain on health and social care services but also reduce the gap in health inequalities.[6]

However, designing effective public health interventions that increase population physical activity is a considerable challenge.[7,8] Implementing such interventions in a way that does not increase health inequalities might even be more difficult. Studies have shown that programmes to increase physical activity often fail to reach deprived communities and those most in need, suggesting

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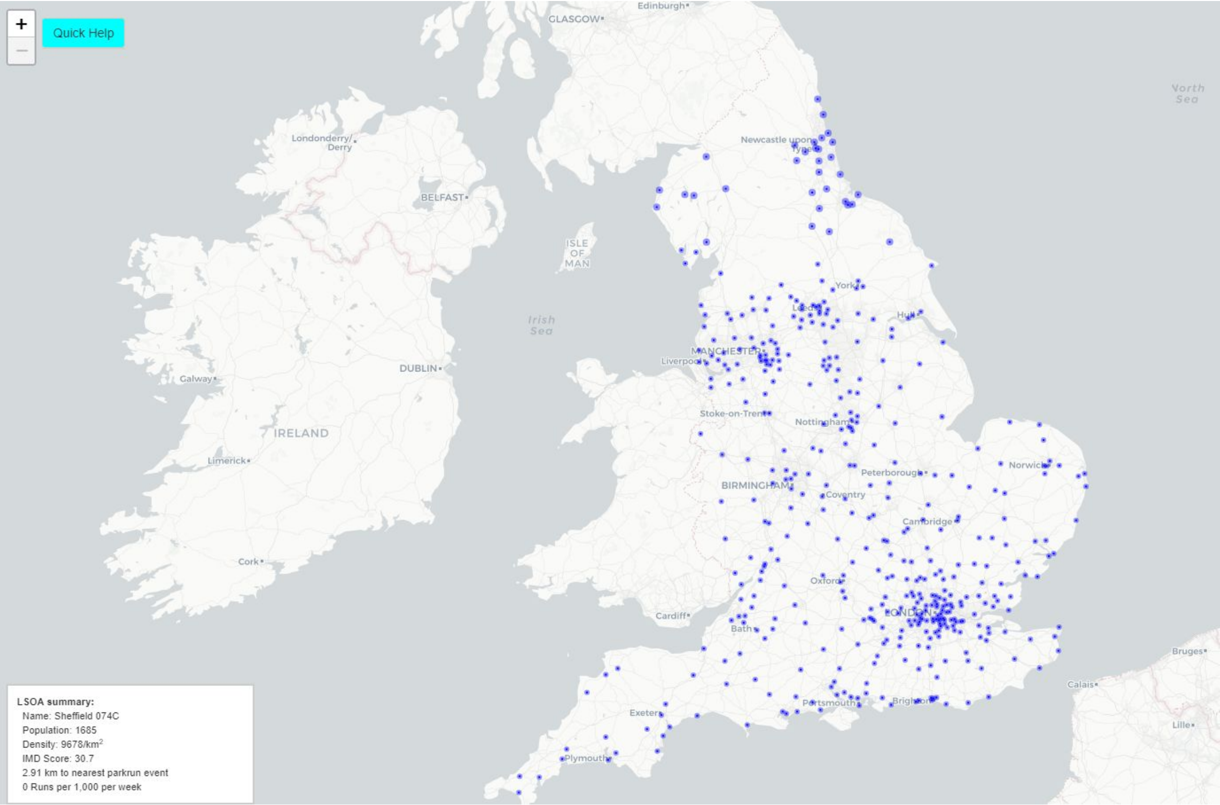


Greedy search algorithm

More formally, we define that for any candidate green space location j, the objective function $f(j|E)$ provides the sum of parkrun runs r_i over all LSOA i, weighted by the squared IMD score w_i^2, given the set of established parkrun event locations $E = \{e_1, e_2, ..., e_{455}\}$:

$$f(j|E) = \sum_{i=1}^{32844} w_i^2 * r_{ij}$$

In the absence of causal estimates, we use the Poisson regression model specified above to predict the expected number of runs r_{ij} for LSOA i based on its IMD score w_i, its (linear) distance to the nearest parkrun event d_{ij}, and its population p_i. The functional form is given below.

$$E(r_{ij}|w_i, d_{ij}, p_i) = \exp\left(\beta_0 + \beta_1 * w_i + \beta_2 * d_{ij} + \ln(p_i) + \in\right)$$

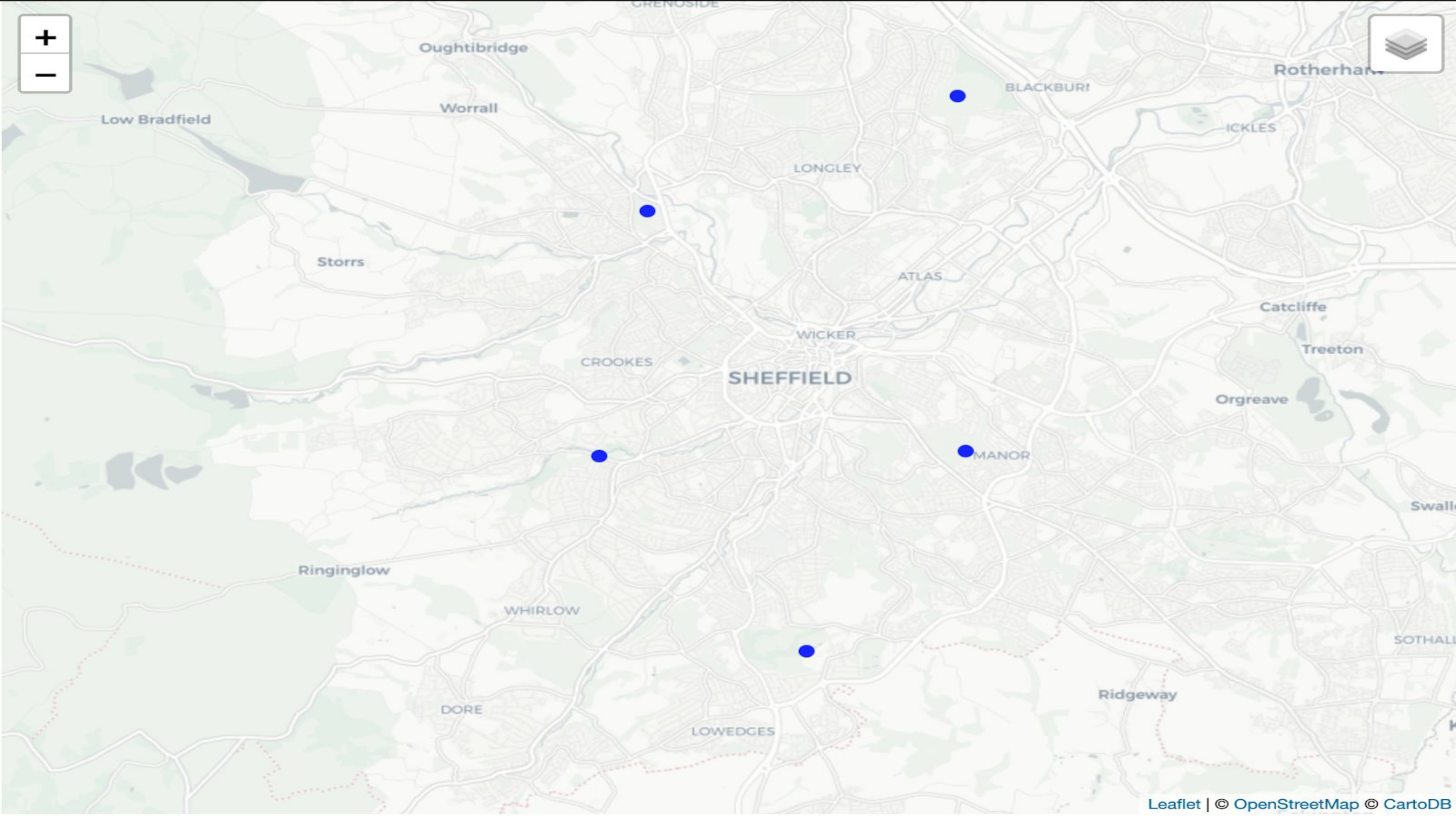
Filling-in the parameter coefficients (see table 3), we derive the following formula:

$$\hat{r_{ij}} = \exp\left(-5.402 - 0.048 * w_i - 0.082 * d_{ij} + \ln(p_i)\right)$$

Note that j can have an effect on r_{ij} through d_{ij}: setting up a new event at location j will reduce the distance to the nearest event for some LSOA i. This means, we evaluate the distances from LSOA is location l_i to all established parkrun event locations $\{e_1, e_2, ..., e_{455}\} \in E$, denoted $\overline{l_i e_1}, \overline{l_i e_2}, \ldots, \overline{l_i e_{455}}$, and to the candidate green space location j, denoted $\overline{l_i j}$, and then take the minimum value, i.e. $d_{ij} = \min(\overline{l_i j}, \overline{l_i e_1}, \overline{l_i e_2}, \ldots, \overline{l_i e_{455}})$.

The expected change in the objective function is computed for all candidate locations j in the set of the available green spaces $C = \{c_1, c_2, \ldots, c_{2842}\}$, and the location with the maximum value is selected. The selection function is expressed in the following formula:

$$\arg\max_{j \in C} f(j|E)$$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Rotherham
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LONGLEY
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Catcliffe
WICKER
Treeton
CROOKES
SHEFFIELD
Orgreave
MANOR
Ringinglow
WHIRLOW
Ridgeway
DORE
LOWEDGES
Leaflet | © OpenStreetMap © CartoDB

Oughtibridge
Worrall
Low Bradfield
Storrs
LONGLEY
ATLAS
SHEFFIELD
Catcliffe
Treeton
Orgreave
MANOR
Ringinglow
WHIRLOW
Ridgeway
LOWEDGES
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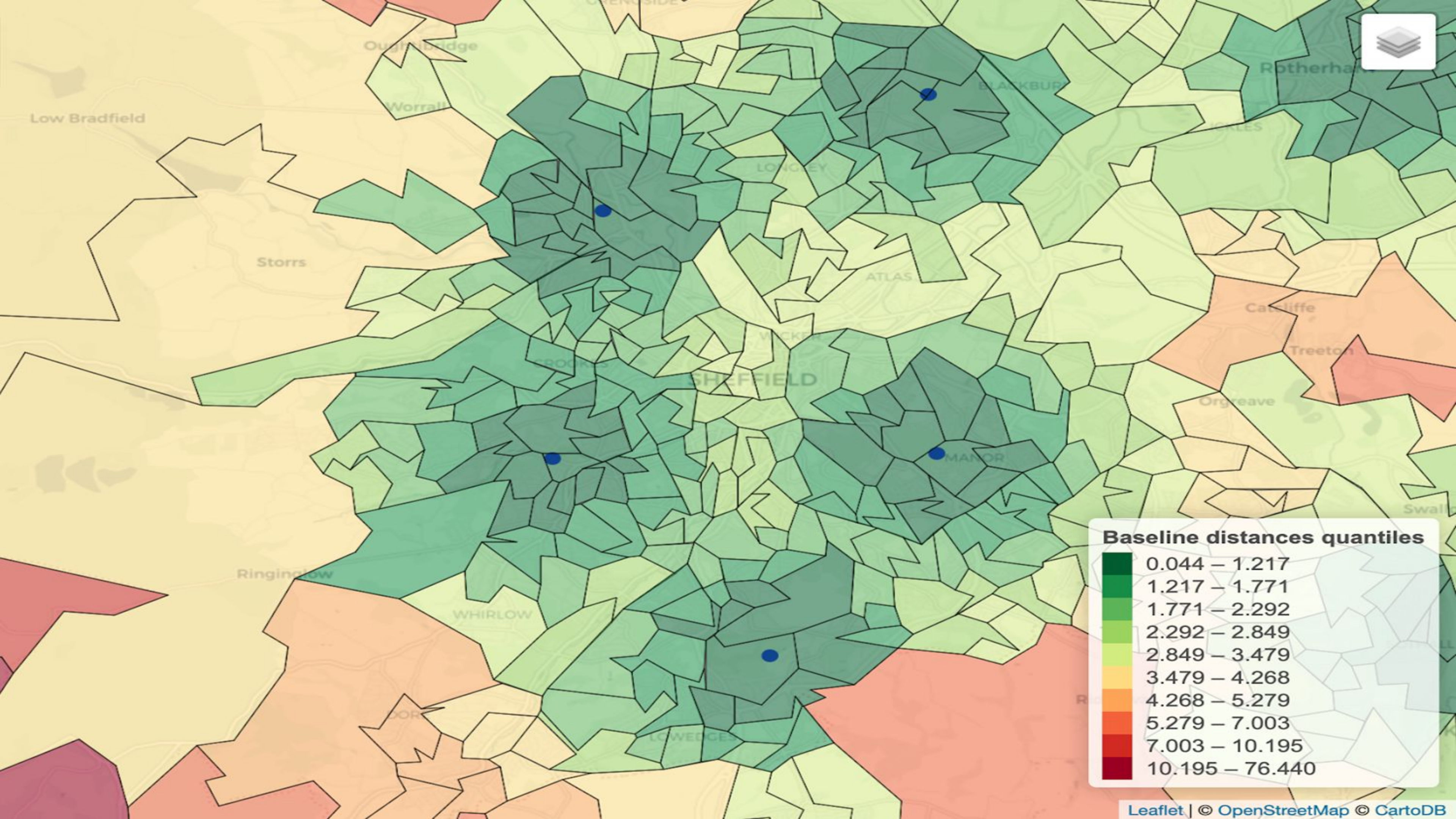
Access = { 2.2 * 1,220 + 4.9 * 2,351+ 2.3*1,915 + 0.7 * 1,844 + 5.1 * 1,530 } = <u>27,702.2</u>

$$\text{Access} = \{ 2.2 * 1{,}220 + 4.9 * 2{,}351 + 2.3 * 1{,}915 + 0.7 * 1{,}844 + 2.0 * 1{,}530 \} = \underline{22{,}959.2}$$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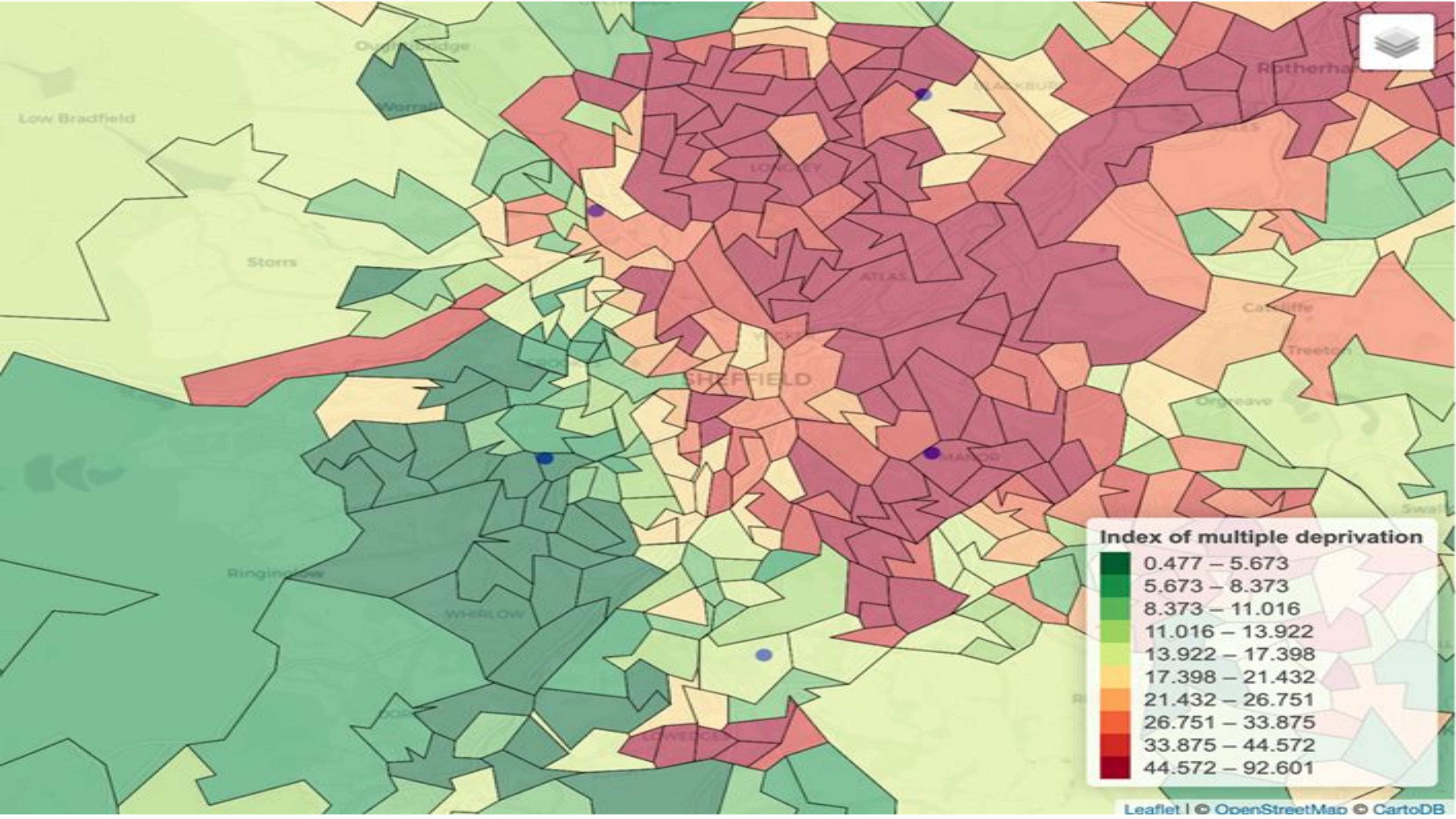
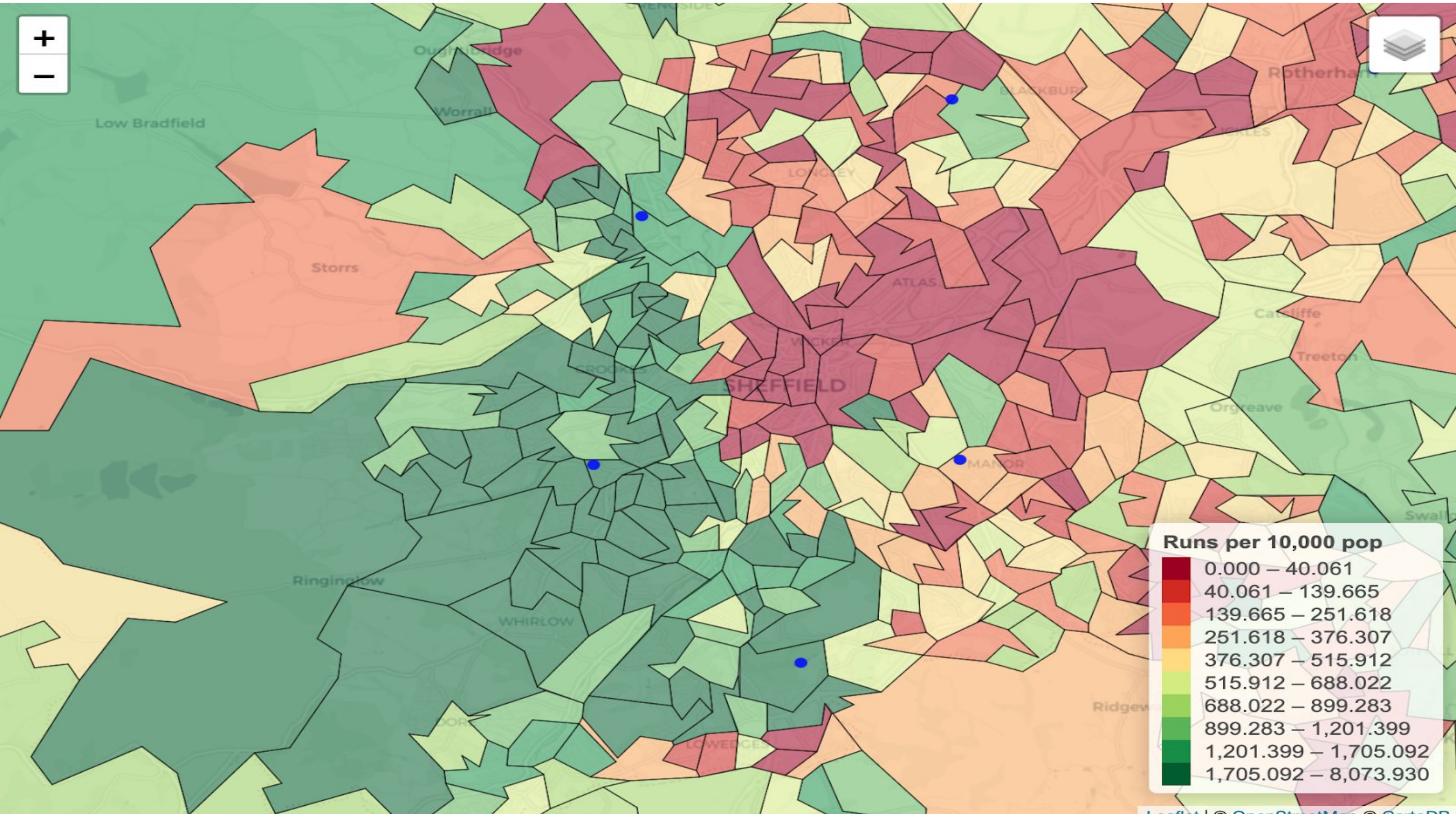
CROOKES
SHEFFIELD
Orgreave
MANOR
Ringinglow
WHIRLOW
LOWEDGES
Baseline distances quantiles
0.044 – 1.217
1.217 – 1.771
1.771 – 2.292
2.292 – 2.849
2.849 – 3.479
3.479 – 4.268
4.268 – 5.279
5.279 – 7.003
7.003 – 10.195
10.195 – 76.440
Leaflet | © OpenStreetMap © CartoDB

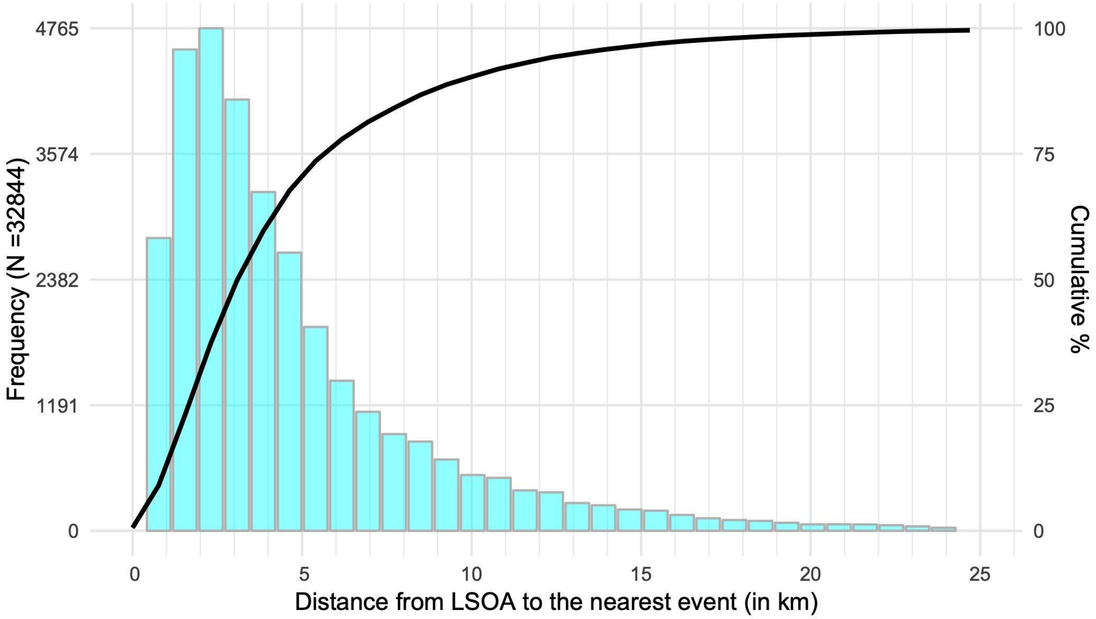

Low Bradfield
Storrs
Ringinglow
WHIRLOW
SHEFFIELD
Treeton
Orgreave
Index of multiple deprivation
0.477 – 5.673
5.673 – 8.373
8.373 – 11.016
11.016 – 13.922
13.922 – 17.398
17.398 – 21.432
21.432 – 26.751
26.751 – 33.875
33.875 – 44.572
44.572 – 92.601
Leaflet | © OpenStreetMap © CartoDB



Oughtibridge
Worrall
Low Bradfield
Storrs
LONGLEY
ATLAS
SHEFFIELD
CROOKES
Ringinglow
WHIRLOW
MANOR
Catcliffe
Treeton
Orgreave
LOWEDGES
Runs per 10,000 pop
0.000 – 40.061
40.061 – 139.665
139.665 – 251.618
251.618 – 376.307
376.307 – 515.912
515.912 – 688.022
688.022 – 899.283
899.283 – 1,201.399
1,201.399 – 1,705.092
1,705.092 – 8,073.930

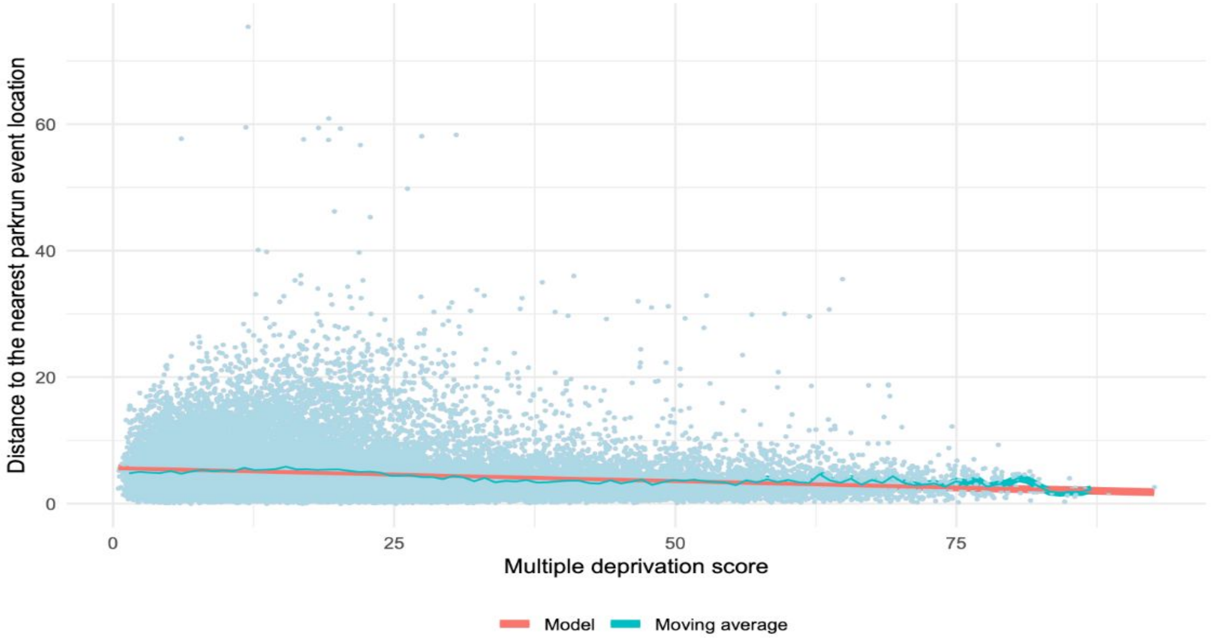
Results

1. How good is geographical access to parkrun?



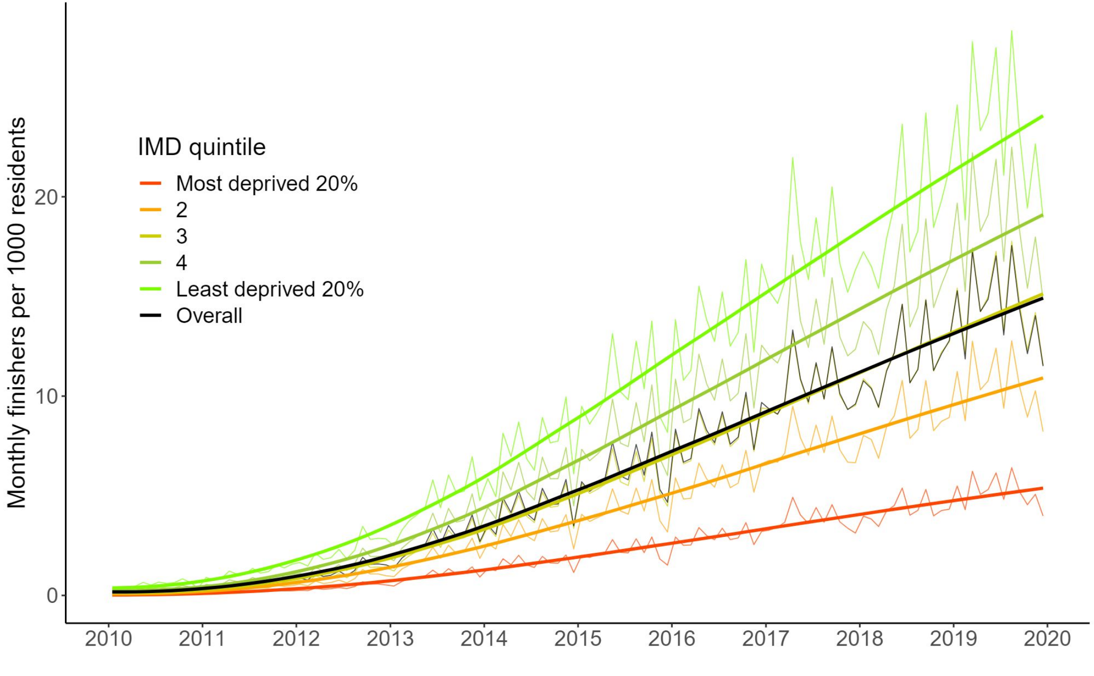
Results

2. How equitable is geographical access?



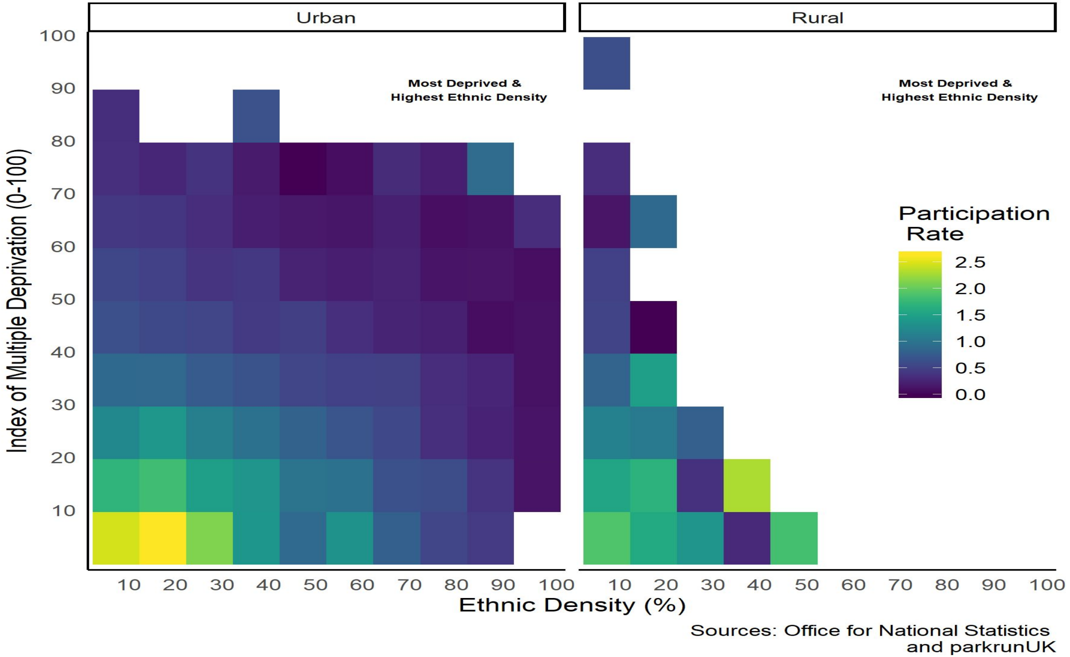
Results

3. How good is participation in parkrun?



Results

4. How equitable is participation?

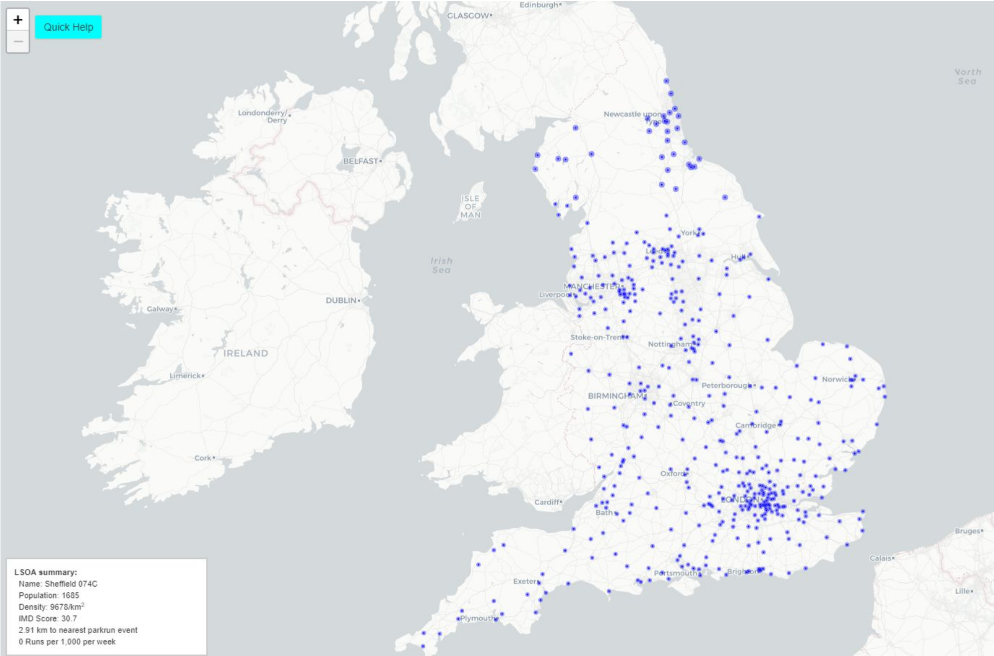


Where should parkrun locate 200 new parkrun events?

	Access	Participation
Efficiency	1. Maximize overall access.	3. Maximize overall participation.
Equity	2. Maximize deprivation weighted access.	4. Maximize deprivation weighted participation.

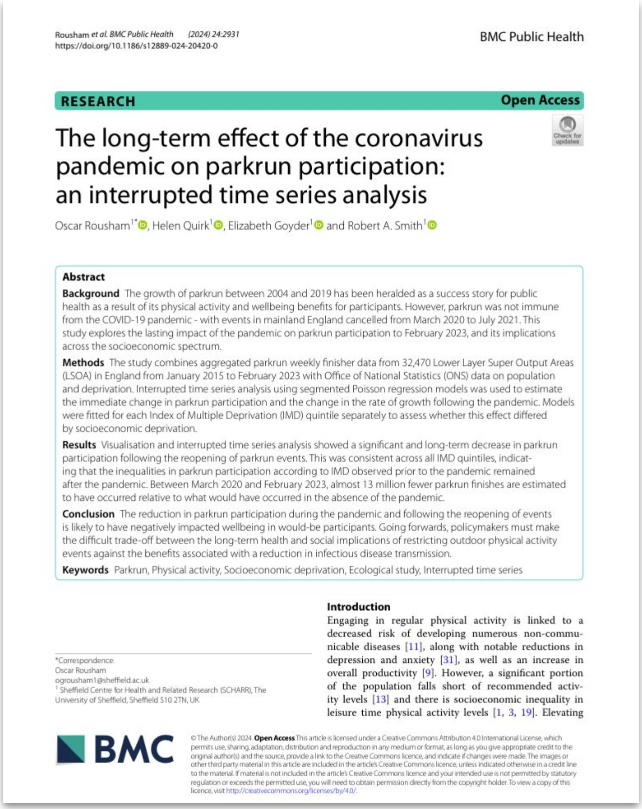
Results

Where should parkrun locate 200 new parkrun events?



https://iolmap.shinyapps.io/parkrun/

Pandemic Policy on ‘parkrun’ Participation



Rousham *et al. BMC Public Health* (2024) 24:2931
https://doi.org/10.1186/s12889-024-20420-0

BMC Public Health

RESEARCH Open Access

The long-term effect of the coronavirus pandemic on parkrun participation: an interrupted time series analysis

Oscar Rousham[1*], Helen Quirk[1], Elizabeth Goyder[1] and Robert A. Smith[1]

Abstract

Background The growth of parkrun between 2004 and 2019 has been heralded as a success story for public health as a result of its physical activity and wellbeing benefits for participants. However, parkrun was not immune from the COVID-19 pandemic - with events in mainland England cancelled from March 2020 to July 2021. This study explores the lasting impact of the pandemic on parkrun participation to February 2023, and its implications across the socioeconomic spectrum.

Methods The study combines aggregated parkrun weekly finisher data from 32,470 Lower Layer Super Output Areas (LSOA) in England from January 2015 to February 2023 with Office of National Statistics (ONS) data on population and deprivation. Interrupted time series analysis using segmented Poisson regression models was used to estimate the immediate change in parkrun participation and the change in the rate of growth following the pandemic. Models were fitted for each Index of Multiple Deprivation (IMD) quintile separately to assess whether this effect differed by socioeconomic deprivation.

Results Visualisation and interrupted time series analysis showed a significant and long-term decrease in parkrun participation following the reopening of parkrun events. This was consistent across all IMD quintiles, indicating that the inequalities in parkrun participation according to IMD observed prior to the pandemic remained after the pandemic. Between March 2020 and February 2023, almost 13 million fewer parkrun finishes are estimated to have occurred relative to what would have occurred in the absence of the pandemic.

Conclusion The reduction in parkrun participation during the pandemic and following the reopening of events is likely to have negatively impacted wellbeing in would-be participants. Going forwards, policymakers must make the difficult trade-off between the long-term health and social implications of restricting outdoor physical activity events against the benefits associated with a reduction in infectious disease transmission.

Keywords Parkrun, Physical activity, Socioeconomic deprivation, Ecological study, Interrupted time series

Introduction

Engaging in regular physical activity is linked to a decreased risk of developing numerous non-communicable diseases [11], along with notable reductions in depression and anxiety [31], as well as an increase in overall productivity [9]. However, a significant portion of the population falls short of recommended activity levels [13] and there is socioeconomic inequality in leisure time physical activity levels [1, 3, 19]. Elevating

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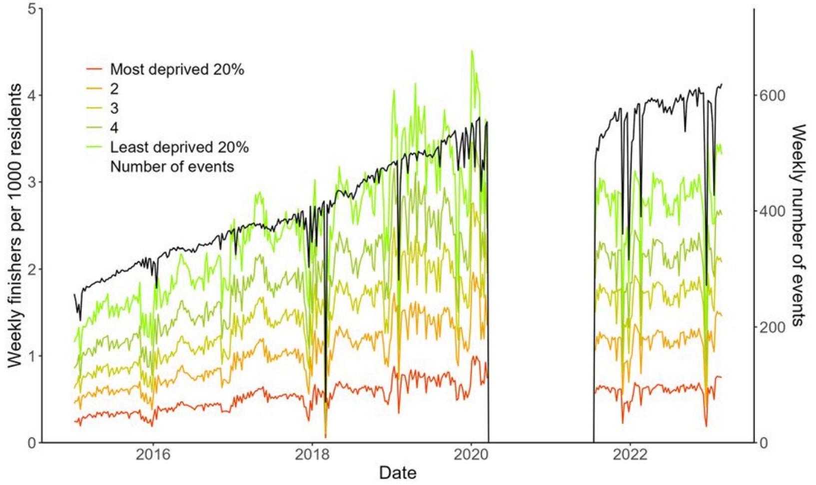

Fig. 1 Weekly number of parkrun finishers in England per 1,000 residents by Index of Multiple Deprivation Quintile, and number of parkrun events in operation, from January 2015 to February 2023

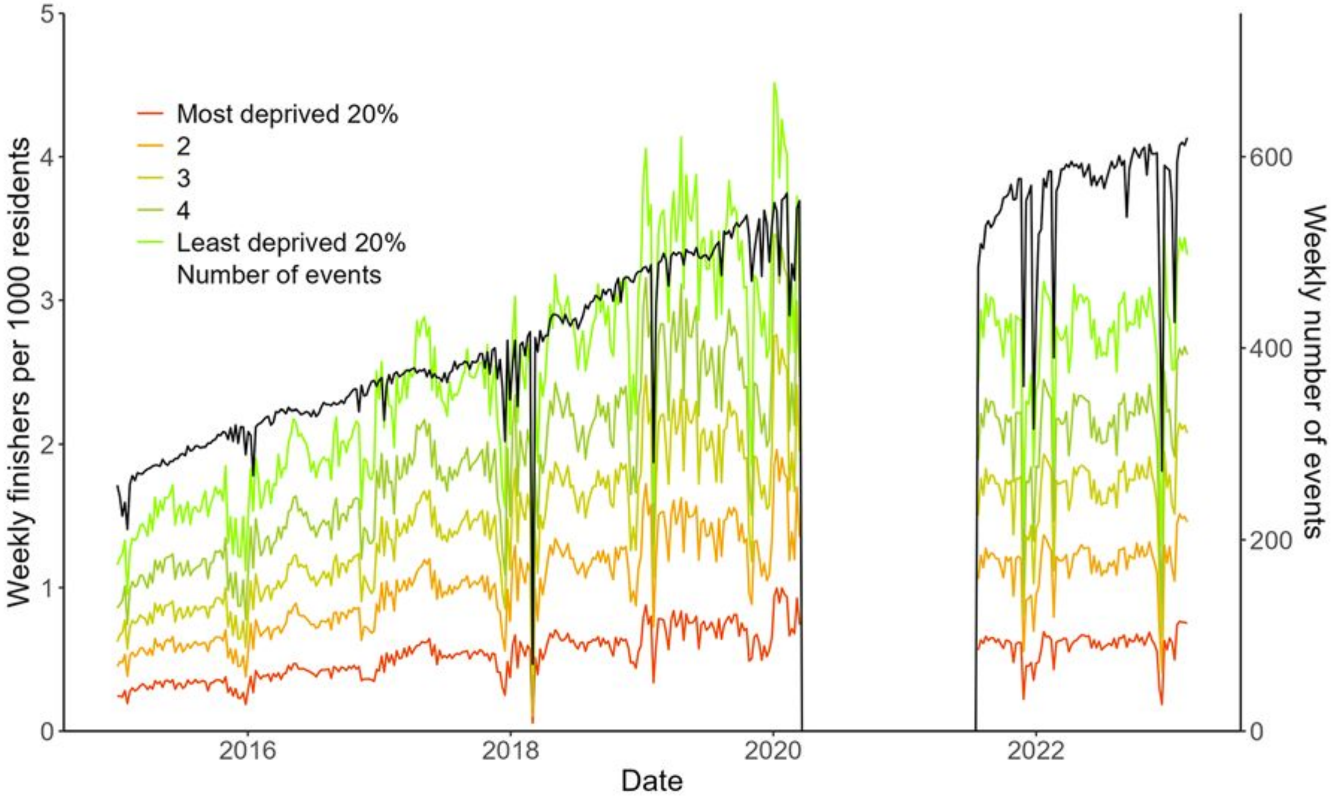

Fig. 1 Weekly number of parkrun finishers in England per 1,000 residents by Index of Multiple Deprivation Quintile, and number of parkrun events in operation, from January 2015 to February 2023

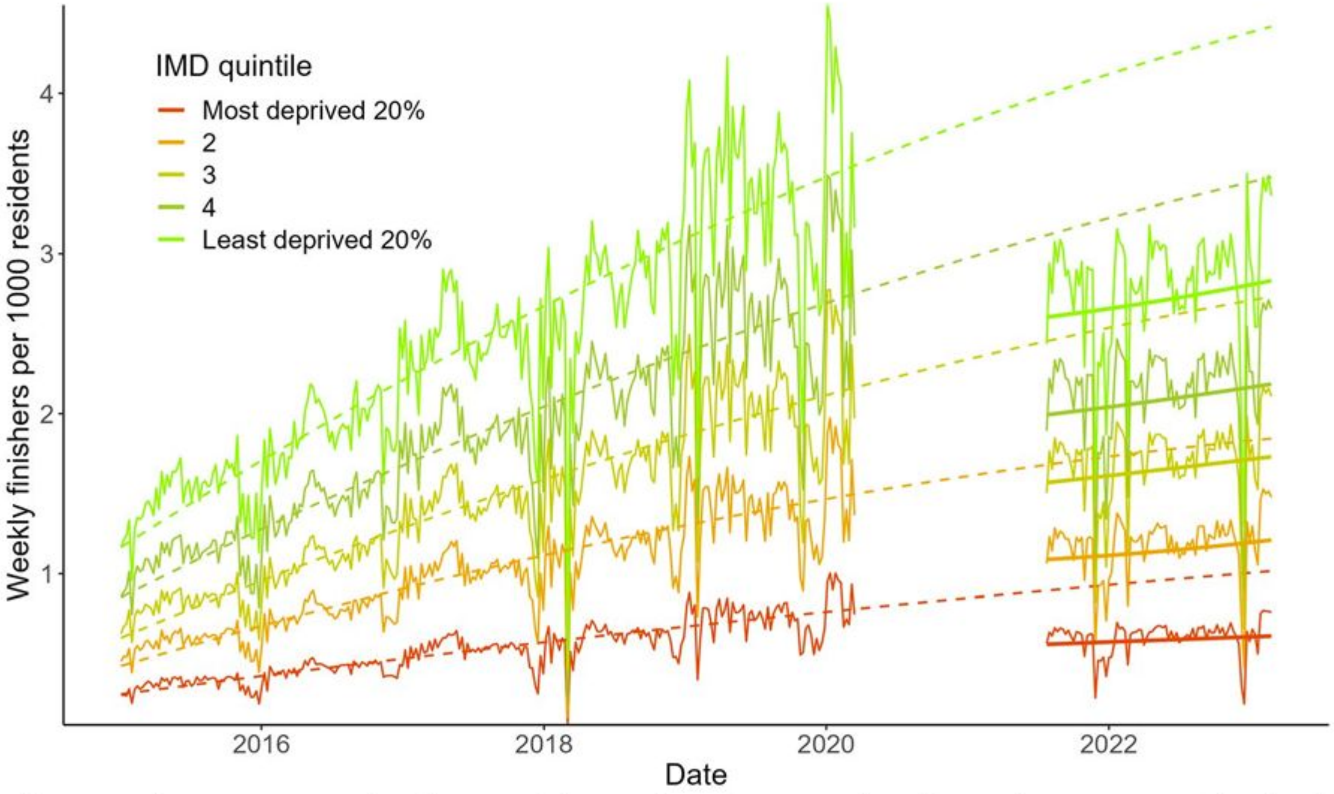

Fig. 2 Counterfactual (expected participation in the absence of the pandemic) compared to observed participation. The thin lines show the observed participation rates by IMD each week. The dotted lines show the pre-pandemic trend ignoring seasonal variation extrapolated across the study period. The solid lines show the post-pandemic trend, ignoring seasonal variation

Open source & impact

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Having a great time at the @N8CIR ReproHack reproducing the research in this really interesting PrePrint about @parkrunUK by @waq0r, @R06ertSm1th and colleagues:

Does ethnic density influence community participation in mass participation physical activity events?

Authors: Robert A. Smith, Paul P. Schneider, Alice Bullas, Steve Haake, Helen Quirk, Rami Cosulich1, Elizabeth Goyder
DOI: 10.12688/wellcomeopenres.15657.2
Submitted by rasmith3

Mean reproducibility score: 9.2/10 | **Number of reviews:** 5

Where should new parkrun events be located? Modelling the potential impact of 200 new events on socio-economic inequalities in access and participation

Authors: Schneider PP, Smith RA, Bullas AM, Bayley T, Haake SS, Brennan A, Goyder E
Submitted by hub-admin

Mean reproducibility score: 7.0/10 | **Number of reviews:** 3

https://www.reprohack.org/

"Rob and colleague Dr. Paul Schneider developed a statistical tool (an algorithm) which searched through all of the greenspaces in England and ranked the top 200 by predicted public health impact.

One example of how the statistical tool was used is the creation of Bowling Park parkrun, located in a deprived area of Bradford. Our local Ambassador, working with community groups, identified the location as an option for a parkrun event – which was corroborated by Rob's work – and the event became a reality for the local people." (parkrunUK, 2020).

https://blog.parkrun.com/uk/2020/12/08/using-research-to-improve-inclusivity/

Publications

Smith, R.A., Schneider, P.P., Cosulich, R., Quirk, H., Bullas, A.M., Haake, S.J. and Goyder, E., 2021. Socioeconomic inequalities in distance to and participation in a community-based running and walking activity: A longitudinal ecological study of parkrun 2010 to 2019. Health & Place, 71, p.102626. https://doi.org/10.1016/j.healthplace.2021.102626

Schneider, P.P., Smith, R.A., Bullas, A.M., Bayley, T., Haake, S.S., Brennan, A. and Goyder, E. 2020. Multiple deprivation and geographic distance to community physical activity events — achieving equitable access to parkrun in England. Journal of Public Health. 48;53(189). https://doi.org/10.1016/j.puhe.2020.09.002

Smith, R., Schneider, P., Bullas, A., Haake, S., Quirk, H., Cosulich, R. and Goyder, E., 2020. Does ethnic density influence community participation in mass participation physical activity events? The case of parkrun in England. Wellcome Open Research, 5(9), p.9. https://doi.org/10.12688/wellcomeopenres.15657.2

Rousham, O., Quirk, H., Goyder, E. et al. The long-term effect of the coronavirus pandemic on parkrun participation: an interrupted time series analysis. BMC Public Health 24, 2931 (2024). https://doi.org/10.1186/s12889-024-20420-0

Open Source Code

https://github.com/RobertASmith/DoPE_Public

https://github.com/RobertASmith/parkrun_temporal_23

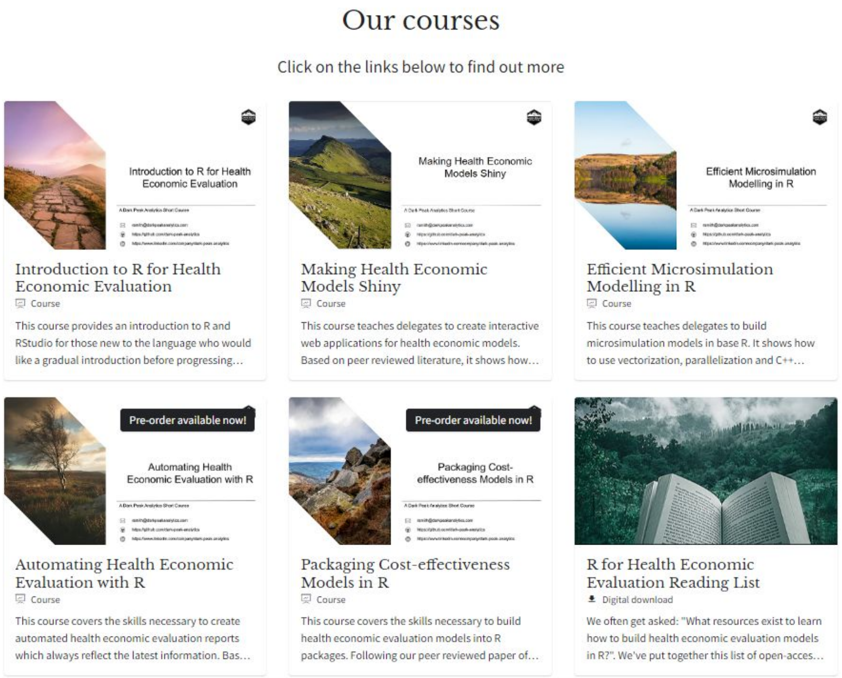
https://github.com/RobertASmith/parkrun_temporal

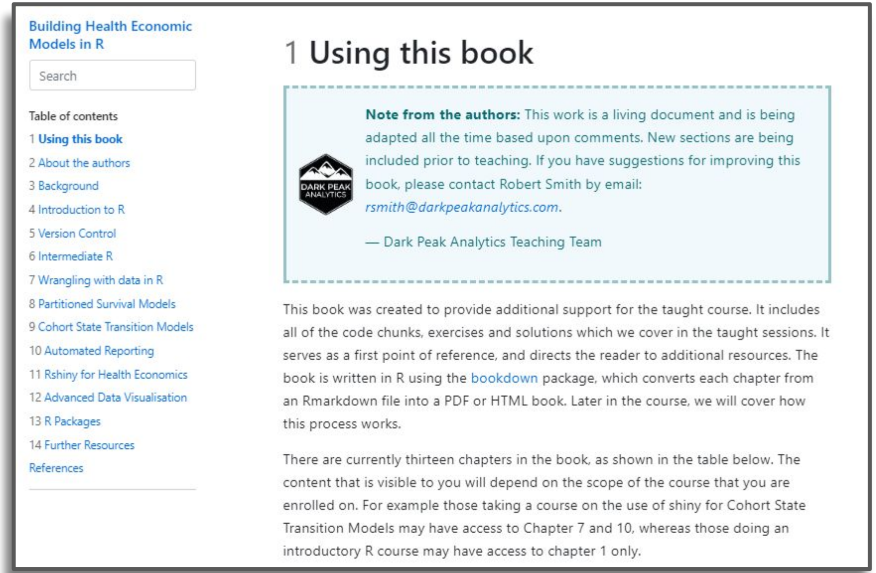
https://github.com/RobertASmith/parkruntimeseries

https://github.com/ScHARR-PHEDS/iolmap_revision

https://github.com/ScHARR-PHEDS/parkrun_book

(*Not so*) Short Course





https://www.courses.darkpeakanalytics.com/